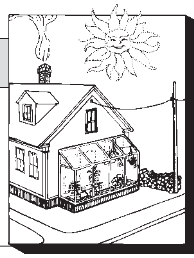
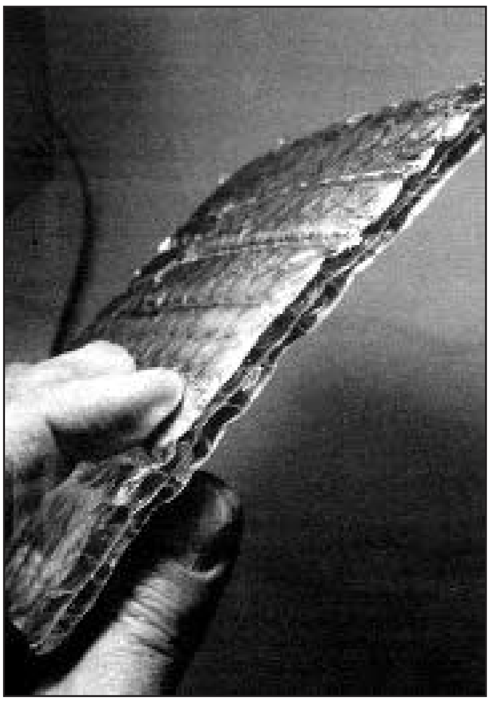


Bubble, Bubble, Foil and Trouble

by J.D. Ned Nisson

Recently I received a sample of 1/4-inch-thick foil-faced bubble pack insulation material (FFBP). The accompanying brochure claims that a floor with the material stapled to the bottom joist surface will have an R-value of R-14.7. Another section claims R-7.8 for the material added to a basement wall between two layers of furring strips. Beneath both claims is a qualifying statement which explains that the insulation has demonstrated R-values of R-8.3 for heat flow up, R-14.3 for heat flow down, and R-9.8 for heat flow horizontal under standard conditions for the ASTM C-236 test for R-values in a 6-inch cavity.



Bubble-pack insulation has a polyethylene core and foil facers. Despite some differences in thickness and makeup, all brands have similar thermal performance.

Can 1/4-inch-thick shiny bubble pack create R-14.7 in a floor? Or R-7.8 on a basement wall? And what is the ASTM C-236 test anyway?

Three companies currently offer a variety of bubble-pack products in the United States. The most aggressively promoted product is Reflectix (Reflectix Inc., PO Box 108, Markleville, IN 46056; 800/879-3645). The other two products are Foil-Ray (Energy Saver Imports Inc., 2150 W. 6th Ave., Unit E, Box 387, Broomfield, CO 80020; 303/469-1787) and Astro-Foil (Innovative Energy Inc., 1119 West 145th Ave., Crown Point, IN 46307; 219/662-0737). Typical costs are between 30¢ and 40¢ per square foot. Although they vary somewhat in thickness and makeup of the bubble pack layer, all have similar thermal performance in building construction.

Foil-faced bubble pack is actually a combination of conventional mass insulation (the polyethylene bubble pack core) and radiant barrier (metallic foil facers). Laboratory tests show that the material itself has an R-value of about R-1 for a 1/4-inch thickness. If applied to the surface of a wall or sandwiched between two components, without an air space, it thus adds about R-1 to the overall R-value of the assembly.

The primary value of this material, however, is not as a mass insulation, but as a radiant barrier. When installed with air spaces on one or both sides, the shiny foil surface blocks radiant heat transfer, causing each air space to have an R-value ranging from R-3 to R-6, depending on heat flow direction and temperature difference.

Arrows, Astronauts and Lab Tests

To explain the thermal performance of FFBP, promotional brochures typically include an arrow graph similar to that in Figure 1 showing that radiation is the dominant mode of heat transfer through walls. The implication is that a radiant barrier is far more effective than mass insulation (fiberglass, cellulose, foam) since it blocks radiation while mass insulation only blocks the lesser conduction and convection components. To illustrate the effectiveness of foil for blocking heat, some brochures include photos of astronauts or fire fighters wearing reflective suits to protect them in outer space or burning buildings.

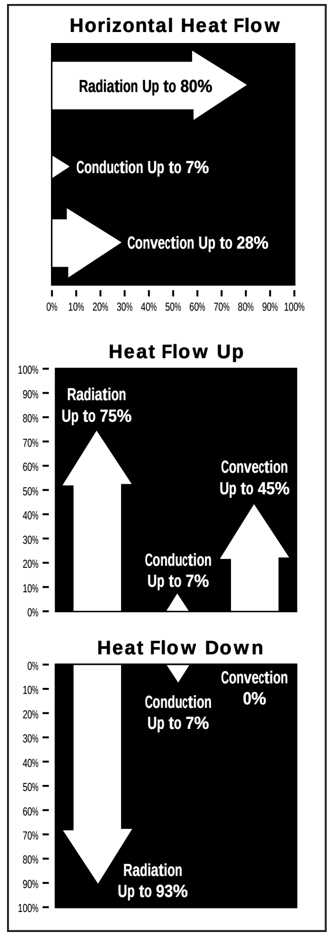


Figure 1. *This type of chart appears frequently in radiant barrier promotional literature. It shows that heat transmission in a hollow wall, floor, or ceiling is primarily by radiation. It does not, however, mean that a radiant barrier will outperform standard insulation. In fact, fiberglass or cellulose is much more effective than a radiant barrier in insulating a hollow cavity.*

These claims and explanations are misleading. The fact is that mass insulation, such as fiberglass batts, does stop radiant heat transfer. How else would an R-19 batt stop over 90% of the heat transfer through a hollow wall? Rather than get bogged down in a discussion of heat transfer physics or the difference between an astronaut and a house, let's just look at some plain bottom-line R-values for wall and floor assemblies with foil-faced bubble pack.

The ASTM C-236 test mentioned in the Reflectix literature is a laboratory technique for measuring the actual R-value of composite wall or floor assemblies. Hundreds of C-236 test results are published in the scientific literature for various types of construction including some with foil-faced bubble pack. The following summary of wall and floor R-values is based on C-236 tests on panels containing bubble pack or single-layer radiant barriers. Because the effectiveness of reflective insulation varies with configuration and temperature, the listed R-values are necessarily approximate, but they should be representative of what would be attained in typical residential construction.

Walls

When installed in a wall with air spaces on both sides, the effective R-value of the bubble pack and both air spaces is about R-7. This is the system recommended in the Reflectix brochure for basement walls (Figure 2), but could theoretically be used on above-grade walls as well. The total R-value of the wall will be the R-value of the

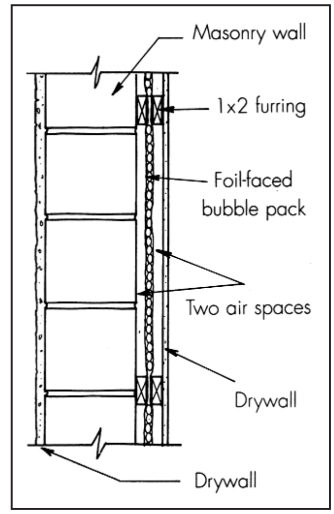


Figure 2. Foil-faced bubble pack on a basement wall. *This approach sandwiches the bubble pack between two layers of furring strips. To attain R-8 for the bubble pack plus the two air spaces, the material must be well-sealed so there are no air leaks around the top and bottom of the bubble pack, and tightly installed so that both air spaces are maintained.*

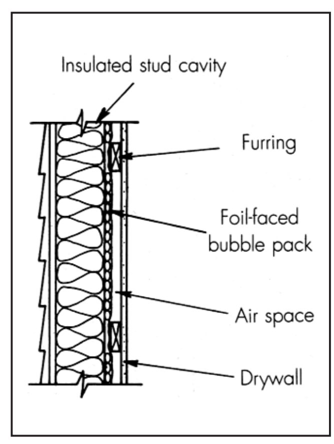


Figure 3. Stud wall installation with single air space. *The bubble pack is stapled to the studs, followed by furring or strapping to create an air space behind the drywall. The bubble pack with air space adds about R-3.5 and serves as a strong and effective vapor retarder.*

base wall plus R-7.

A more practical application for above-grade walls is to create a single air space on one side of the bubble pack (Figure 3). The FFBP is stapled directly to the studs. Furring or strapping is then nailed over the bubble pack, followed by interior drywall. The R-value created by the bubble pack and air space is about R-3.5 as long as the full air space is maintained. A 2x4 wall with R-13 insulation plus this FFBP configuration will have a total R-value of about R-17. (By comparison, the same wall configuration with a standard radiant barrier material instead of the bubblepack would rate about R-16. With a vapor retarder and air space, but no reflective surface, about R-14.5.)

One advantage to the bubble pack in this design is that it is an extremely strong and effective vapor retarder. No additional polyethylene vapor retarder is necessary.

Floors

Radiant barriers are most effective in floors. The R-value of a floor system with bubble pack attached to the bottom of the joists is about R-8 with heat flow down (Figure 4). Keep in mind that this R-value is for the FFBP and air space. If the joist cavity were filled with mass insulation (no air space), then the FFBP would add only about R-1 to R-2 to the total assembly.

What about the R-14.7 mentioned in the Reflectix brochure for floors over crawl spaces? That R-value is possible, but only if the bubble pack is installed in the center of the uninsulated joist cavity with air spaces above and below, and sheathing attached to the bottom joist surface (Figure 5). C-236 tests of this configuration showed measured R-value of about R-14.

One possible problem with this design is that the FFBP forms a vapor retarder on the cold side of the floor assembly. To avoid moisture problems, the bubble pack should be perforated to allow moisture to escape.

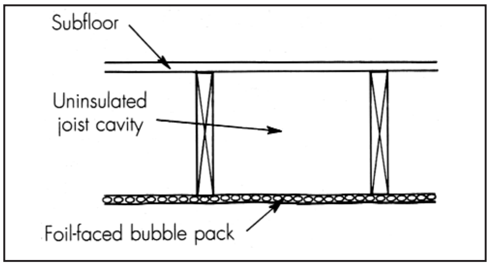


Figure 4. Bubble pack stapled to bottom of joists. *The R-value of the bubble pack and air space above is about R-8. However, if the joist spaces were filled with fiberglass, installing the bubble pack would only add R-1 to R-2 to the assembly.*

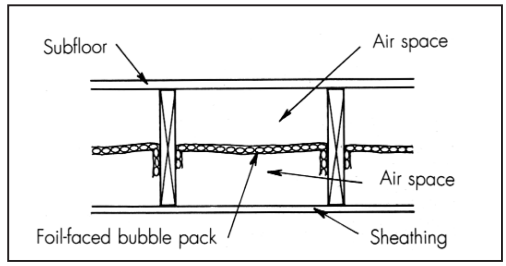


Figure 5. Bubble pack in the center of floor joist cavity. *This is the most effective type of radiant barrier installation, adding about R-14 for the two air spaces plus bubble pack. Its lasting effectiveness depends on the foil surface remaining shiny and dust free.*

Theory Versus Reality

In order to get the R-values mentioned above, the bubble pack must be perfectly installed. For example, in the wall in Figure 3, if the bubble pack bulges and reduces the air space or touches the interior drywall, the system loses effectiveness. In the double air space system shown in Figure 2, if the bubble pack is not tightly sealed to top and bottom plates, air circulation will short-circuit the system. (An experiment at the Saskatchewan Research Council found that a wall with improperly installed reflective insulation actually had a lower measured R-value than the same wall with no insulation. The apparent cause was air circulation around the foil.)

Another concern is durability, not of the material itself, but the surface shininess. In order to retain effectiveness, the material must stay shiny and dust free. This is a controversial topic, but research on attic radiant barriers at Oak Ridge National Laboratory found 50% performance degradation due to dust accumulation or a horizontal surface. It is hard to predict whether or how much dust will accumulate in walls or on a crawlspace ceiling.

Finally there is cost. At 30¢ to 40¢ per square foot for the material alone, bubble pack does not compete well with fiberglass batts on a cost-per-R basis.

All in all, foil-faced bubble pack looks great, feels good and can work. It may be a very practical material for certain applications such as agricultural buildings. But as a residential sidewall or floor insulation, it usually takes a back seat to conventional mass insulation materials because of its installation demands and relatively high cost. ■

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